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ABSTRACT

The primary purposes of this research were to discover any differences between deaf and normal speech compressed 15 or 30 percent related to level of comprehension test, sex of speaker, and form of test, and to learn whether there was a relationship between percent of compression and degree of comprehension. The subjects--219 undergraduates at Montana State University--were randomly assigned to two groups: (1) control, receiving normal speech stimuli, and (2) experimental, receiving deaf speech. The results indicated that subjects had higher degrees of comprehension for non-deaf speech compressions than for deaf speech compressions. The level and form of the test did not appear to be operative factors. The sex of the speaker was not found to be a pure variable, and in all instances 30 percent compressions were not as highly significant as 15 percent compressions. The most conclusive results of this research were those findings related to percentage of compression, which tended to confirm for deaf speech the earlier findings relating to normal speech that time-span compressions can be detrimental to comprehension. (LG)

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A Study of Comprehension of Compressed Deaf Speech

Ray E. Weisenborn and Jack R. Olson

Research and educational planning involving compressed speech are usually restricted to employment of normal speech compressed in time span (CRCR, 1971). Numerous variables have been tested, including applications to persuasion, word intelligibility, word rate, and listener factors. Limited application has been made to some areas of communication handicaps, such as the blind (Nolan, et. al., 1962; Foulke, 1967).

A review of the literature did not reveal studies which had investigated paramaters of communication handicaps involving compressed deaf speech. The investigators were concerned with this area of oral communication ability in the deaf because the slow and methodical utterances of the deaf tend to be a major factor in unintelligibility.

Research Related to Experimental Variables

The oral communication abilities of the deaf are aptly described in research by Hudgins and Numbers (1942) and Hudgins (1946). In the first study, seven categories of errors in articulation of consonants were noted and five categories of vowel error were recorded. It was found that non-rhythmical speakers were the most difficult to understand. In the second

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CS 200 207

study, five problems were isolated as being related to intelligibility of deaf speech. These included short, irregular breath groups that interrupted speech flow, excessive expenditure of breath, false groupings of syllables, lack of proper coordination between breathing muscles and articulatory organs, and a slow, methodical utterance. Theoretically, these problems might be alleviated if compression would eliminate between-word dead space, increase the speech rate, and reduce audible breathiness.

In a number of studies, word comprehension has been measured as a function of word rate. Within the range extending from 126 to 172 wpm, Diel, White, and Burke (1959) found listening comprehension to be unaffected by the changes in word rate. In the range extending from 125 to 225 wpm, Harwood (1955) found a slight, but insignificant loss in comprehension as word rate was increased. Thereafter, comprehension, as indicated by per cent of test questions answered correctly, declined from 58 per cent correct at 282 wpm, to 26 per cent correct at 470 wpm. Thus, for normal speech, extreme compression of time span appears to be detrimental to comprehension.

According to Goldhaber and Weaver (1968) and Goldhaber (1970), normal hearing male listeners had significantly higher comprehension scores on four rates of compression and three levels of language difficulty than did normal hearing female listeners. They found in the same study that material graded at the freshman level of difficulty yielded significantly higher comprehension scores than materials graded at either the eighth grade or graduate school levels of difficulty. Also, it was found that for comprehension of normal speech compressed at different difficulty levels, rate of comprehension and sex of listener appear to be independent variables.

While these studies give indications of the potentially operative variables of normal compressed speech, they do not reveal application to handicapped individuals whose oral communication abilities might be enhanced if their speech were compressed. The research design which follows describes a study which theorized that compression of deaf speech would result in increased comprehension levels.

Procedures

Subjects

Ss were 219 students enrolled in introductory speech courses at Montana State University during Spring Term 1972. They were randomly assigned into control and experimental test groups.

Measures

The measures of comprehension were based upon the Gray Oral Reading Tests (Bobbs-Merrill, 1963). In these tests vocabulary and content comprehension is obtained from different test forms for grade levels one through six. In an attempt to reduce the variable of college level language achievement (Goldhaber and Weaver, 1968), forms C and D on the fourth and sixth grade language levels were employed.

Treatment

Treatment consisted of playing tape recorded tests from the Gray Tests. Control and experimental groups received identical test content. Control

Ss received the content via normal speech stimuli and experimental Ss received the content via deaf speech stimuli. Because deaf speech encompasses such a wide range of intelligibility, the following experimental stimuli descriptions by a certified Speech Pathologist and Teacher of the Deaf are offered:

#1 - Female; congenitally deafened; exhibits a hearing loss which prevents her from receiving and understanding speech, although she appears to benefit from a hearing aid. Speech was rated moderately intelligible; articulation fair to good; pitch, inflection, and rate tended to be monotone; rhythm fair; rate of speaking slow.

#2 - Male; congenitally deafened; has not made use of residual hearing and does not use amplification. Speech was rated fairly intelligible; articulation fair; pitch, inflection, and rate tended to be monotone; rhythm poor; rate of speaking slow.

All Ss received the tape recorded stimuli at fifteen or thirty per cent compression via the Fairbanks method of compression. This method changes the rate of recorded speech by the sampling method (18 millisecond deleted samples). Test one stimuli was fifteen or thirty per cent compression, male or female, test form C or D, of one grade level test. Ss then answered orally administered comprehension questions. Test two stimuli employed identical compression percentage, opposite sex speaker, and alternate, but same level, test form. Comprehension was tested in the same manner.

Fifteen and thirty per cent compressions were employed in the study as preliminary testing at zero and fifteen per cent compression did not produce a significant control or experimental F-ratio. ($p < .10$) These results reconfirm the findings of Diel, White, and Burke (1959).

Hypotheses

The following hypotheses were tested by the procedure described above:

I. There is no difference between comprehension tests of deaf and normal speech compressed fifteen or thirty per cent.

II. There is no difference between comprehension tests of deaf and normal speech compressed fifteen or thirty per cent on fourth and sixth grade language levels.

III. There is no difference between comprehension tests of deaf and normal speech compressed fifteen or thirty per cent because of sex of speaker.

IV. There is no difference between comprehension tests of deaf and normal speech compressed fifteen or thirty per cent because of form of test.

Data Analysis

Because the Gray Tests allow for partially correct responses, the data were coded to reflect zero to four correct responses with half-points being scored; thus, the raw score range was zero to nine. Mean scores were obtained for all comprehension tests. Table 1 reports these data.

The data obtained from the measures were analyzed by analysis of variance and *t*-tests for independent samples.

Results

Analysis of variance was based upon three primary factors, sex of speaker, level of test, and test form. Between experimental and control group factors, F-ratios were significant ($F < .01, < .05$, and $< .05$). Therefore, the hypothesis of no comprehension test differences between normal and deaf speech compressed fifteen or thirty per cent (hypothesis I) was rejected. Subsequent analysis of the data tested experimental and control factor differences.

Non-hypothesis matched-pairs tests were also run. Table 2 reports these data.

Results Relating to Primary Hypotheses

Hypothesis II. There is no difference between comprehension tests of deaf and normal speech compressed fifteen or thirty per cent on fourth and sixth grade language levels.

All Tests between experimental and control conditions achieved high levels of significance ($p < .005$) with the exception of thirty per cent compression of the sixth grade level ($p < .05$). Within matched-pairs tests, clear significance was exhibited between fourth and sixth grade levels at fifteen per cent compression ($p < .01$), but only marginal significance at the thirty per cent level ($p < .10$).

Hypothesis III. There is no difference between comprehension tests of deaf and normal speech compressed fifteen or thirty per cent because of sex of speaker.

All between condition tests again achieved high levels of significance ($p < .005$) except the thirty per cent compression for females ($p < .01$). For matched-pairs tests, the fifteen per cent compressions on fourth and sixth grade levels were clearly significant ($p < .005$), but the thirty per cent compressions on these levels were only marginally significant ($p < .10$).

Hypothesis IV. There is no difference between comprehension tests of deaf and normal speech compressed fifteen or thirty per cent because of form of test.

Again, all tests between experimental and control conditions achieved high levels of significance ($p<.005$), with the exception of the thirty per cent compression for form C of the Gray Tests ($p<.005$). Matched-pairs tests between forms at fifteen per cent were clearly significant at the fourth and sixth grade levels ($p<.05, <.01$). The thirty per cent compression between the forms was marginally significant at the fourth grade level ($p<.10$) and clearly significant at the sixth grade level ($p<.01$).

Discussion

The primary purposes of this research were to discover any differences between deaf and normal speech compressed fifteen or thirty per cent related to level of comprehension test, sex of speaker, and form of test, and whether there was a relationship between per cent of compression and degree of comprehension. The data clearly indicate that between deaf and normal speech there are significant differences for all factors investigated in the study. The means and their levels of significance reported in Tables 1 and 2 show that normal speech compressions achieved significantly higher degrees of comprehension than did respective deaf speech compressions.

The data also indicate that within experimental conditions there are extremely divergent degrees of comprehension. The design of the study and the experimental stimuli employed offer speculative reasons for these differences. For comprehension of compressed deaf speech, level and form of test do not appear to be operative factors. (Nor do they appear operative for compressed normal speech.) Because of the diversity of deaf speech quality, it cannot be determined from this research if sex of speaker is a

viable independent variable. Analysis of the data manipulating the factors of hypotheses II through IV indicated that sex of speaker was not a pure variable. Rather, it tested one deaf speech quality against another. The design of the study employed only one Ss for each sex in both deaf and normal speech. Prior to further research in this area, scales should be developed which accurately reflect the evaluation of divergent standards of deaf speech. The extreme t-statistic significances of Table 1 would, most likely, be a result of the sex of speaker false assumption. Perusal of the large differences between male-female mean scores in the experimental conditions reported in Table 2 lend further support to sex of speaker confounding variable.

It should also be noted that in all instances, thirty per cent compressions were not as highly significant as fifteen per cent compressions. Thus, the most conclusive results of this research are those findings related to percentage of compression. There does not appear to be a positive relationship between per cent of compression and degree of comprehension. The results of this research tend to confirm for deaf speech the findings related to normal speech reported by Diel, White, and Burke (1959), and Harwood (1955) that time-span compressions can be detrimental to comprehension.

Table 1

Comprehension Test Means and Levels
of *t*-statistic Significance

Compression	Sex	Level of Test	Form of Test	Means for Experimental	Means for Control	*t*-statistic Significance
15	-	4	-	2.82	7.78	.005
15	-	6	-	2.28	5.82	.005
30	-	4	-	2.17	4.77	.005
30	-	6	-	2.50	3.48	.05
15	M	-	-	1.45	6.35	.005
15	F	-	-	3.61	7.17	.005
15	*EM:CF			1.45	7.17	.005
15	*EF:CM			3.61	6.35	.005
30	M	-	-	2.04	4.52	.005
30	F	-	-	2.64	3.69	.01
30	*EM:CF			2.04	3.69	.005
30	*EF:CM			2.64	4.52	.005
15	-	-	C	2.57	6.81	.005
15	-	-	D	2.49	6.71	.005
30	-	-	C	2.56	3.69	.005
30	-	-	D	2.09	4.52	.005

*EM= emperimental male
ET= experimental female
CM= control male
CF= control female

Table 2

Matched-Pairs Means and Levels of *t*-statistic Significance for Sex of Speaker, Level of Test, and Form of Test, by Compression Percentages

Compression	Sex	Level of Test	Form of Test	Means for Experimental	Means for Control	*t*-statistic Significance
15	M	4	C	1.36	7.67	.01
30	M	4	C	1.53	4.22	.01
15	F	4	C	3.89	7.37	.01
30	F	4	C	2.60	4.50	.05
15	M	6	C	1.35	6.36	.01
30	M	6	C	2.75	1.08	.01
15	F	6	C	4.42	5.93	.05
30	F	6	C	3.92	4.87	.10
15	F	4	D	4.00	8.00	.01
30	F	4	D	2.32	4.11	.01
15	M	4	D	2.44	8.00	.01
30	M	4	D	2.70	7.75	.01
15	F	6	D	2.06	7.45	.01
30	F	6	D	1.00	1.23	.10
15	M	6	D	1.16	4.00	.01
30	M	6	D	1.85	6.13	.01

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